
Collider-Accelerator Department Overview

Presented to

RHIC Facility Annual Science and Technology Review

Derek I. Lowenstein
July 22, 2009

FY2008 Nuclear Physics S&T Review Action Items

Recommendations

None

C-A Department Personnel

COLLIDER-ACCELERATOR DEPARTMENT

Circa May 2009

Mission: “To develop, improve, and operate the suite of particle/heavy ion accelerators used to carry out the program of accelerator-based experiments at BNL; support of the experimental program including design, construction and operation of the beam transports to the experiments, plus support of detector and research needs of the experiments; to design and construct new accelerator facilities in support of the BNL and national missions. The C-A Department supports an international user community of over 1500 scientists. The Department performs all these functions in an environmentally responsible and safe manner under a rigorous conduct of operations approach.”

Staff: The Collider-Accelerator Department headcount is:

	<u>Total</u>	<u>NP*</u>	<u>EBIS</u>	<u>NSRL</u>	<u>OTHER</u>
Ph.D. Scientists	55	51	1	2	1
Postdoctoral Fellows	6	6	0	0	0
Engineers/Professional	136	125	3	5	3
Designers/Technicians	170	157	3	7	3
Admin./Clerical	<u>18</u>	<u>17</u>	<u>0</u>	<u>1</u>	<u>0</u>
Totals	385	356	7	15	7

*Does not include - 15 Magnet Division employees charged to NP.

Additional support - 14 FTEs are purchased as Laboratory assigned trades.

C-AD Accelerator Physics Students (2002-2009)

Lin, Fanglei	Bai	Post Doc at Physics
Chang, Xiangyun	Ben-Zvi	C-AD Staff Member
Calaga, Rama	Ben-Zvi	C-AD Staff Member
Grimes, Jacob	Ben-Zvi	Researcher in Texas
Wang, Gang	Ben-Zvi	C-AD Post Doc
Wang, Erdong	Ben-Zvi	Current Ph.D. student
Wang, Yi-Chun	Ben-Zvi	Current Ph.D. student
Wu, Qiong	Ben-Zvi	C-AD Post Doc
Rajulapati, Lokesh	Fischer	Graduate Student
Hammons, Lee	Litvinenko	Current Ph.D. student
Longhi, Emily	Litvinenko	Accelerator Scientist at Diamond light source
Roychowdhury, Samadrita	Litvinenko	Researcher at Xerox Corp.
Chalut, Kevi	Litvinenko	Post Doc at Duke Univ.
Mehta, Pratik	Litvinenko	Current Ph.D. student
Webb, Stephen	Litvinenko	Current Ph.D. Student
D'Imperio, Nicholas	Luccio	BNL Computational Science Center
Ranjbar, Vahid	MacKay	Post Doc at TechX Corp.
Kanesue, Takeshi	Okamura	Current Ph.D. Student
Tamura, Jun	Okamura	Current Ph.D. Student
Cardona, Javier	Peggs	Prof. of Physics, Bogota, Colombia
Fliller, Ray	Peggs/Drees	NSLSII Staff Member
Irigoien, Ubaldo	Peggs/Drees	Post Doc at CELLS light source, Barcelona, Spain
Warner, Arden	Peggs	Physicist, Accelerator Div., Fermilab
Hao, Yue	Ptitsyn	C-AD Post Doc
Takano, Junpei	Roser	Assistant Professor at KEK

CENTER FOR ACCELERATOR SCIENCE & EDUCATION (CASE)

CASE provides an exceptional educational path for students at Stony Brook to pursue a career in accelerator science.

CASE takes advantage of the collaboration with BNL, by providing students the opportunity to learn on the state-of-the-art accelerators at BNL and by having the BNL staff participate in the teaching of courses and advising degree candidates. CASE proposes to take full advantage of the US Particle Accelerator School to attract the brightest undergraduate students by providing the opportunity to study the basics of accelerator physics and attract them to a graduate career at SBU. The partnership of SBU and BNL under CASE, is a powerful combination of institutions that will foster accelerator science education in the US and put SBU at the forefront of accelerator science education.

Tom Hemmick (SBU) and Vladimir Litvinenko (BNL) co-direct CASE.

FY 2009 Awards and Publications

FY 2009 Awards (to date)

- **IEEE Fellow – I. Ben-Zvi, November 2008**
- **AAAS Fellow – T. Roser, December 2008**
- **APS/DPB Executive Committee Member-at-Large – M. Minty, December 2008**
- **BNL Engineering Award – A. Zaltsman and W. Zhang, June 2009**
- **APS Doctoral Dissertation Award – R. Miyamoto, June 2009**
- **BNL Spotlight Awards – 29 members of C-AD (to date)**

FY 2009 Publications (to date)

- **84 Publications**
 - **13 journals, 11 refereed**
 - **71 conference proceedings**
- **Approx. 10 invited talks**

C-AD Program Areas (FY2009)

OPERATIONS

RHIC

- p↑-p↑ operations @ 250 GeV and 100 GeV
 - First 250 GeV physics run
 - PHENIX, STAR, pp2pp

AGS

- E972, E973 Proton interrogation, U line (DTRA)

Booster

- NASA Space Radiation Laboratory (NSRL)

Linac

- Isotope production (BLIP)

Tandem

- Commercial Users

C-AD Program Areas (FY2009)

PROJECTS

- EBIS (DOE / NASA)
- Stochastic cooling (AIP, ARRA)
- Electron lens (ARRA)
- 56 MHz SRF cavity (AIP)
- 9 MHz RF system (Ops)
- Spin flipper (RIKEN)

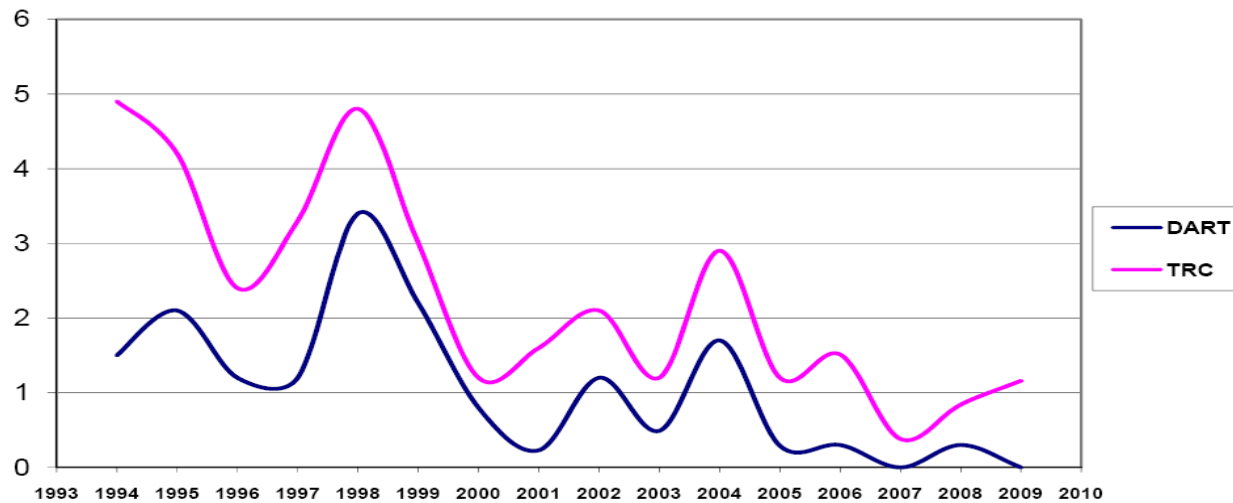
R&D

- Energy Recovery Linac (NP / US Navy)
 - 40-50 MeV, 0.5 amps, 2-pass recirculator
 - eRHIC, electron cooling, military application
- eRHIC / MeRHIC design
 - eRHIC (10-20 GeV); MeRHIC (4 GeV)
- eRHIC SRF cavity
 - ESS and CERN collaboration under discussion
- RHIC low energy ion operations (< 20 GeV cm)
- LARP (DOE HEP)
- Joint neutrino source R&D effort with FNAL (DOE HEP) continues
- CIRC conceptual design for isotope production (NP)
- Hadron therapy accelerator and delivery system

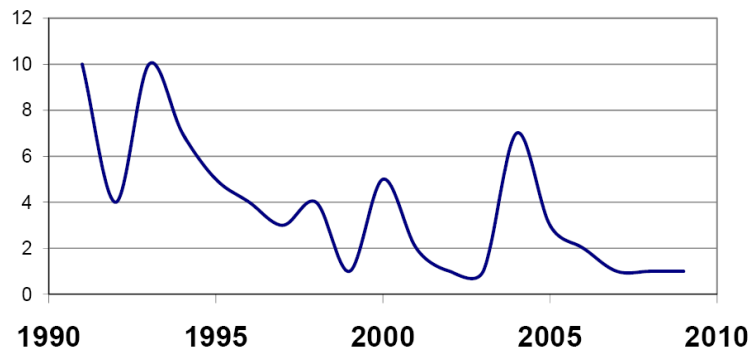
RHIC Performance

Trends in ESH Performance at C-AD

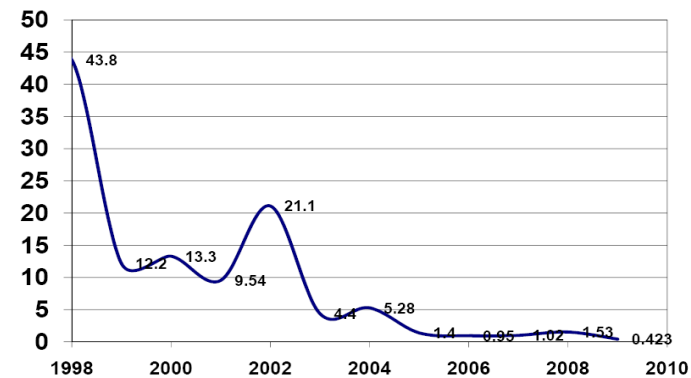
C-AD Injury/Illness Rates
(# per 100 FTE)



Annual Number of Reportable Occurrences at C-AD






Calendar Year Collective Dose, person-rem

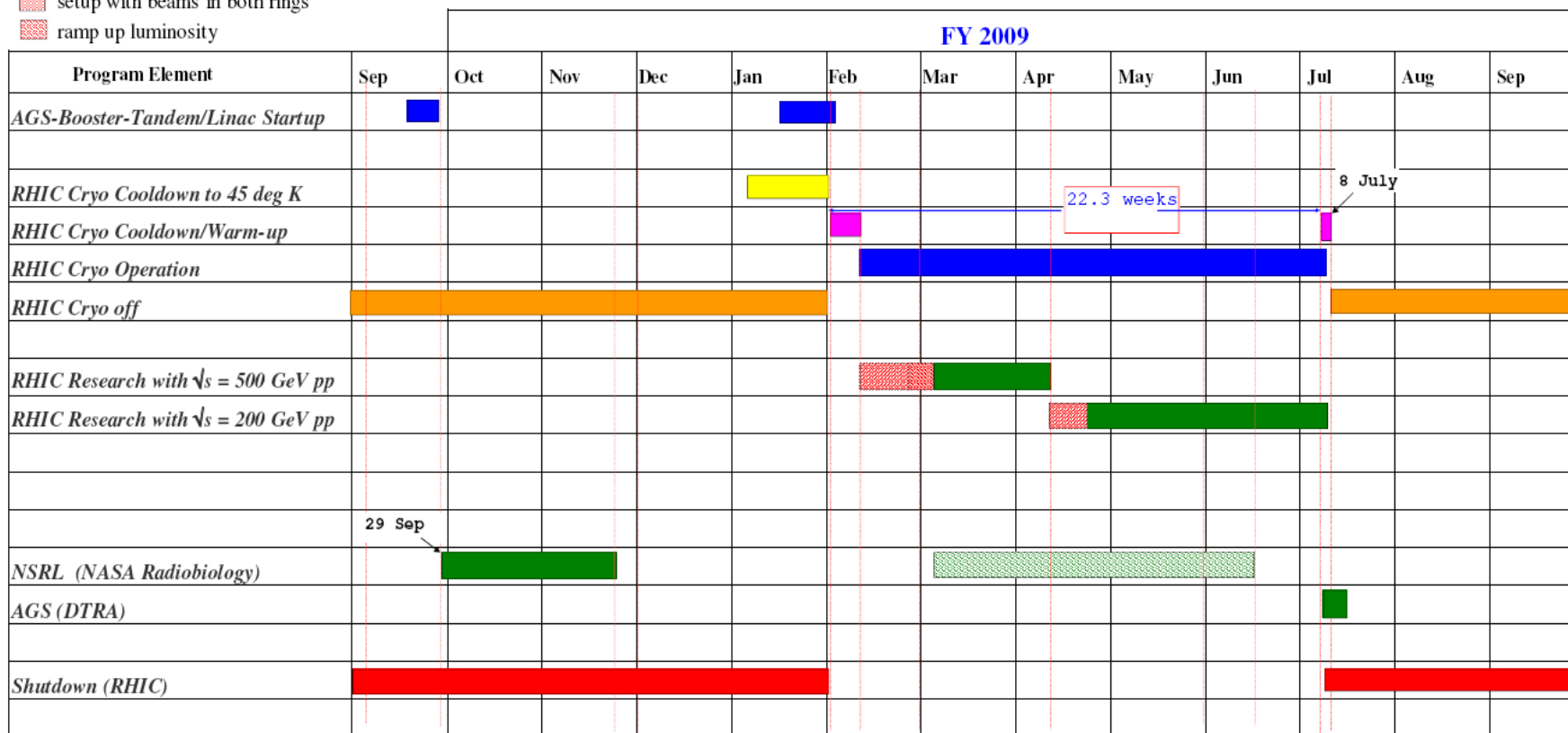


C-A Operations-FY09

18 June 09

-  concurrent with RHIC
-  setup with beams in both rings
-  ramp up luminosity

AS Run/Planned



RHIC $p\uparrow$ - $p\uparrow$ Highlights

250 x 250 GeV for PHENIX and STAR

- First physics run at 500 GeV cm
- Average store polarization of 35% (measured by H-jet)
- Delivered luminosity of 8.5×10^{31} (peak) and 5.5×10^{31} (average)
- Issues:
 - Polarization ramp **transmission**
 - **Working point** and 10Hz triplet oscillations
 - Collimation efficiency, beam dump
 - Polarimeter rate dependence

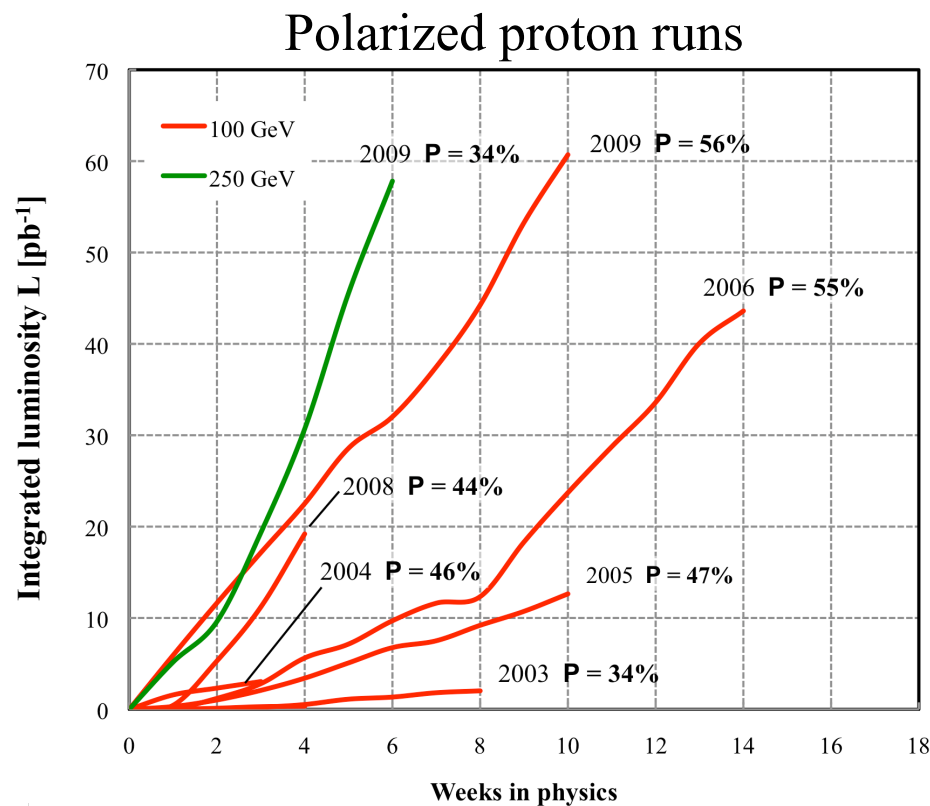
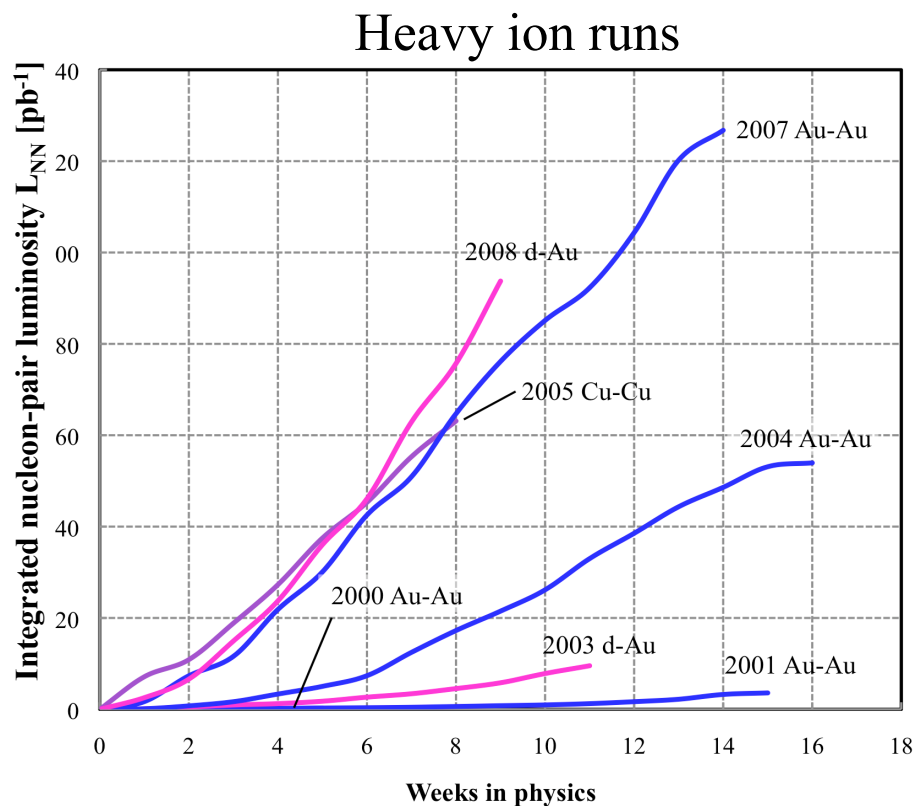
100 x 100 GeV for PHENIX, STAR and pp2pp

- Despite higher peak luminosity average luminosity did not improve much over FY2008 (3.5×10^{31} (peak), 2.3×10^{31} (aver.)
 - 5.0×10^{31} (peak), 2.8×10^{31} (average)
 - Average store polarization of 55% (**measured by H-jet**)
- Issues:
 - β^* reduction from 1.0 m to 0.7 m did not improve average luminosity
 - Yellow ramp transmission is **intensity limited**
 - Polarimeter rate dependence

Beam availability was 81%. Met DOE performance measure.

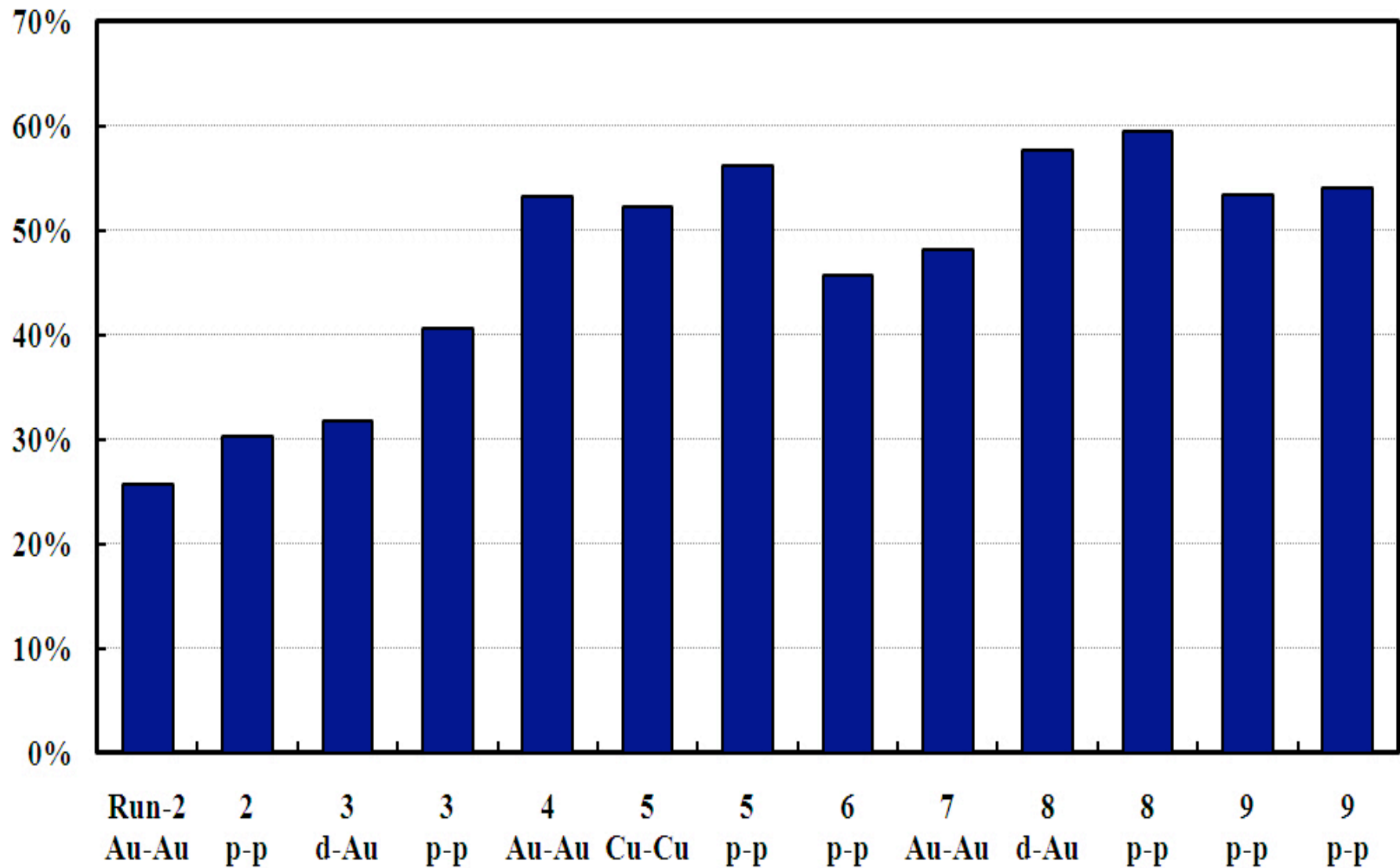
Delivered Integrated Luminosity and Polarization

RHIC IS 50% ABOVE THE ENHANCED ION LUMINOSITY PERFORMANCE LIMIT, 40% BELOW PROTON LUMINOSITY GOAL @ 100 GeV. BOTH HAVE REACHED A PLATEAU. UPGRADES ARE UNDER CONSTRUCTION.

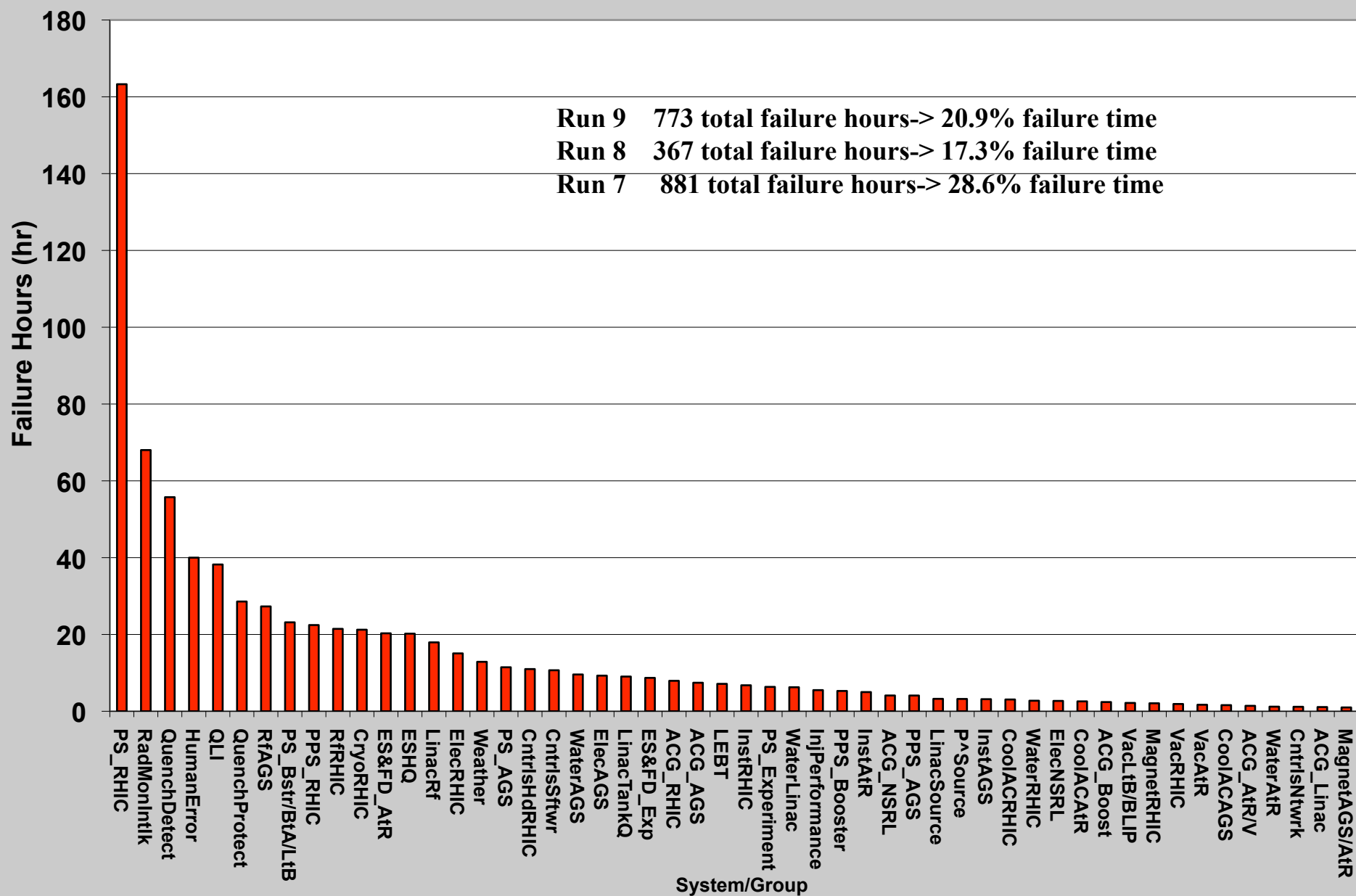


Stochastic cooling of ions (FY2010-2011), 56 MHz cavity (FY2011) and beam-beam compensation with electron lenses (FY2012) of polarized protons are the next upgrade steps.

RHIC time in store



RHIC Run 9 p⁺p⁺ Failure Hours (> 1 hr.) by System/Group

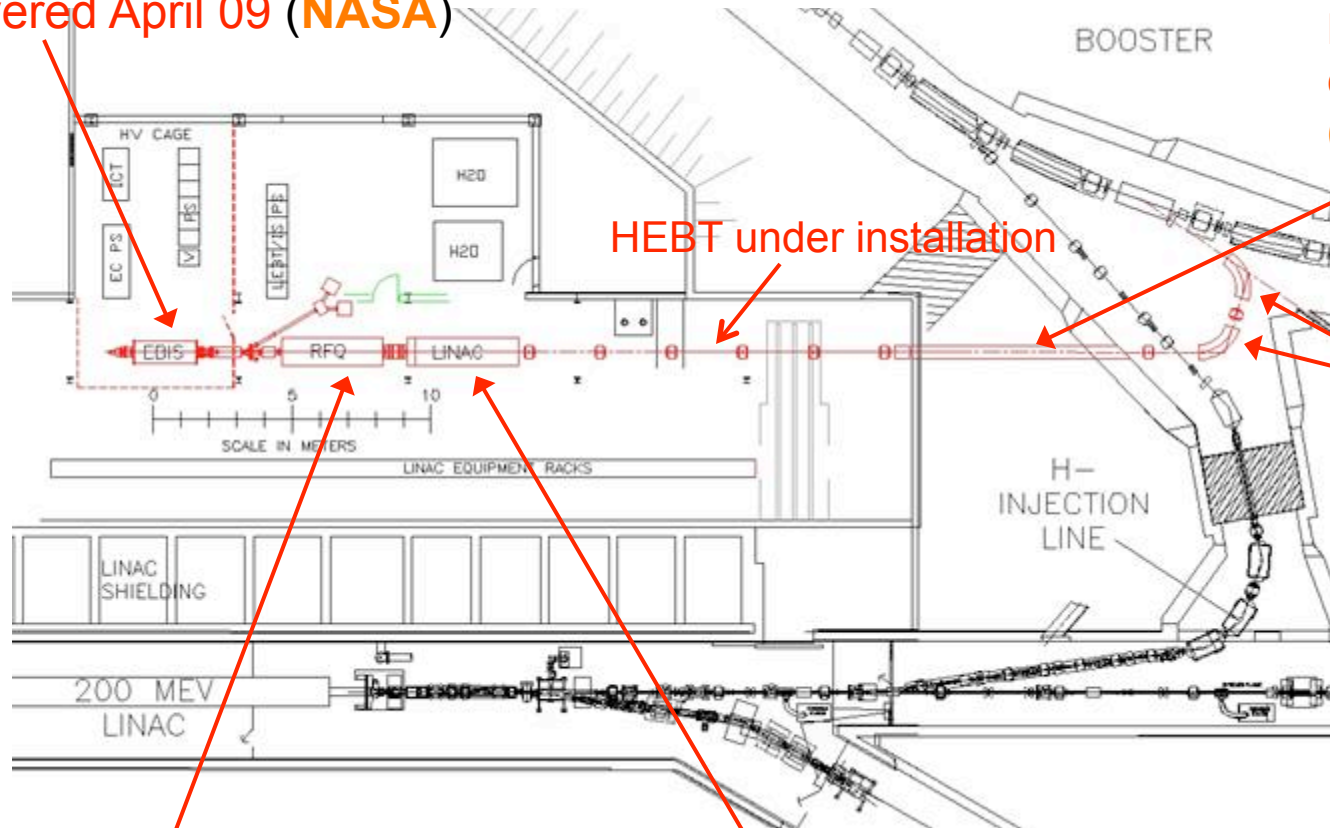


EBIS Scientific/Technical Motivation

- Replaces the two Tandems as the Booster preinjector, resulting in more stable beam intensities (no stripping foils).
- Eliminates the need to use the 860-meter long transport line from Tandem to Booster, using instead a much simpler and economic 30-meter long line from EBIS, which will reduce setup time and allow fast switching between beams of different rigidities.
- Capable of providing ions not presently available for the NASA program, such as noble gas ions (major components of galactic cosmic rays), as well as more massive ions such as uranium, and with additional enhancements, polarized helium-3, for the RHIC program.
- Increases flexibility in handling the multiple simultaneous needs of RHIC, NSRL and AGS. Currently, two Tandems are needed for fast beam switching, while the EBIS preinjector will be designed to switch between species in 1 second.
- Improved reliability, setup time and stability should lead to increased integrated luminosity in RHIC and increased productivity for NSRL.
- Reduces operating costs. The Tandem facility requires a staff of approximately 12 FTEs to support maintenance and a 24-hour shift rotation during operations. The Linac-based pre-injector should be able to run unattended at most times, as with the present proton Linac, and will require only a staff of approximately 3 FTEs.

EBIS Project

EBIS SC solenoid –
delivered April 09 (**NASA**)



RFQ – delivered July 08
(**NASA**)

Linac – delivery Sept 09
(**NASA**)

EBIS & Tandem Business Plan

- EBIS will replace the Tandem van de Graaff as the heavy ion injector for both RHIC and NSRL in FY 2011
- Tandem future path will be decided by early FY2010 on the two options:
 - **Continue Tandem Operations as a Stand Alone User Facility**
 - Maintain current technical capabilities , and with improved availability, reduced staff of 6 FTE and efficient schedule, achieve sustainable program of 1200 operating hours at a minimum. Present staffing level is 12 FTE. Unlikely to have a RIF since C-AD staffing is presently in a hiring mode, due to previous chronic FTE support levels, 20 FTE loss to other BNL programs, increased NP and ARRA funding and expected retirements.
 - Develop new programs (e.g., micro-beams, accelerator mass spectrometry) with external support. Collaboration effort with external users, the CFN, Biology and/or Medical Departments.
 - **Cease Tandem Operations**
 - Excess Facility – Requires annual surveillance and maintenance (\$50K)
 - Decommission and reclaim space (\$15M est.)
 - Transfer to EM for future D&D

R&D

C-AD R&D

Luminosity and polarization performance for RHIC

See Roser presentation

eRHIC/MeRHIC design

- SRF ERL and electron gun (BNL, US Navy, AES)
 - eRHIC/MeRHIC electron injector prototype
 - Coherent electron cooling test bed
- eRHIC design (MIT-Bates, Novosibirsk, Jlab)
 - Focus on linac-ring design. ERL will be required.
 - Magnet prototype (LDRD)
 - Reuses substantial number of components from MeRHIC to reduce costs
- SRF ERL cavity (CASE: BNL/SBU))
- Polarized electron source (MIT/BNL)
- Polarized He³ source (BNL)

Machine Advisory Committee

Georg Hoffstaetter, Chair, Cornell

Oliver Bruning, CERN

Alex Chao, SLAC

Jean-Pierre Delahaye, CERN

Geoff Krafft, Jefferson Lab

David McGinnis, FNAL

Kazuhito Ohmi, KEK

Markus Steck, GSI

MAC EXECUTIVE SUMMARY, MARCH 2009

“The C-AD Advisory Committee was presented with material concerning four central topics of RHIC developments which fall under the following headings: stochastic cooling, R&D on ERLs, on RHIC electron-lens, and on eRHIC / MeRHIC. The committee was impressed by the path laid out for the future of RHIC.”

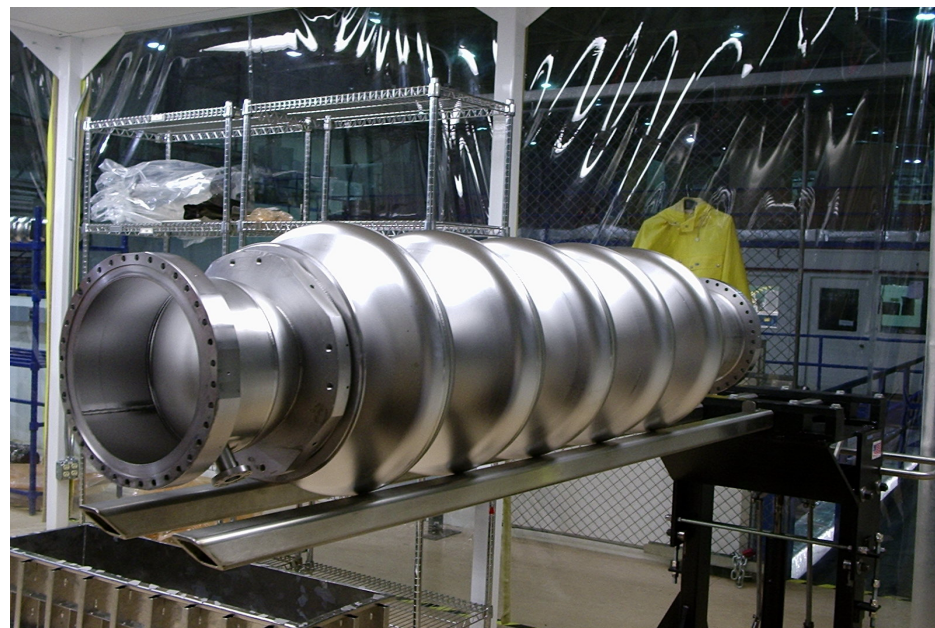
“A significant increase of luminosity for gold on gold collisions can doubtlessly be expected from the additional cooling systems under preparation. The committee encourages building these systems with high priority to benefit in the next ion run. The cooling system with its present frequency window together with the new 56MHz SRF cavity promises significant additional luminosity increase which should be brought about as fast as possible.”

“Because many of the mid and long term options for RHIC depend on Energy Recovery Linac (ERL) technology, C-AD has invested in an ERL test for some time. This foresight is to be commended.”

“R&D efforts on electron-lens compensation of beam-beam effects are encouraged and the proposal for an operational demonstration is strongly supported.”

“The committee was pleased to learn about an effort to provide medium energy electron-ion collisions with the MeRHIC before high energy collisions can be provided at an eRHIC facility.”

Energy Recovery Linac



SRF PROCESSING & TESTING FACILITY

A joint, BNL / Advanced Energy Systems, SRF cavity preparation / cleaning and full scale testing facility is coming on line within 2 months. Funded by BNL patent royalty money. The cleaning facility is located at Advanced Energy Systems (<5 miles from BNL) and the cavity testing facility is at BNL. This will expedite the SRF R&D efforts at BNL and support the national SRF program. The facility supports the construction of SRF cavity structures that are too large to process at TJNAF.



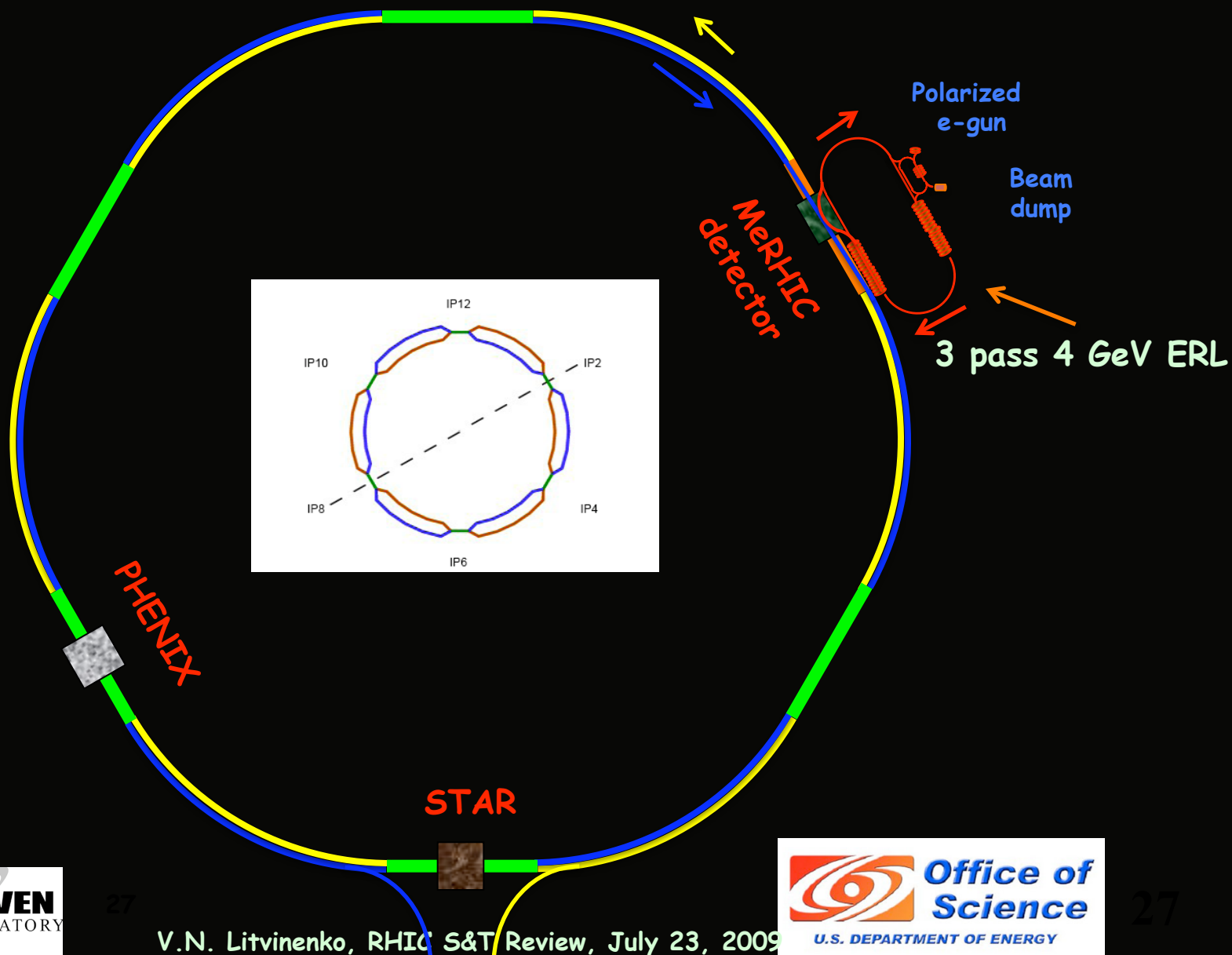
**Chemistry Room &
Cavity Etching (BCP)**

Clean Room & high pressure rinse

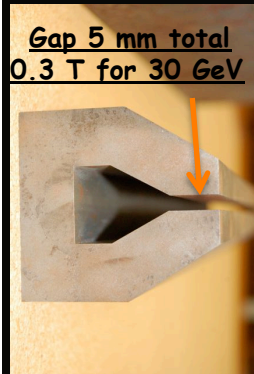
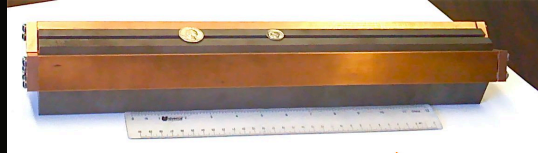
4 GeV e x 250 GeV p - 100 GeV/u Au

MeRHIC

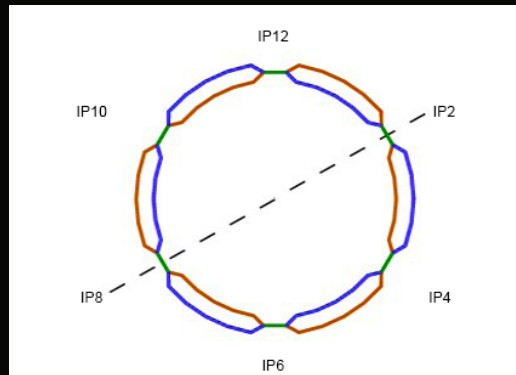
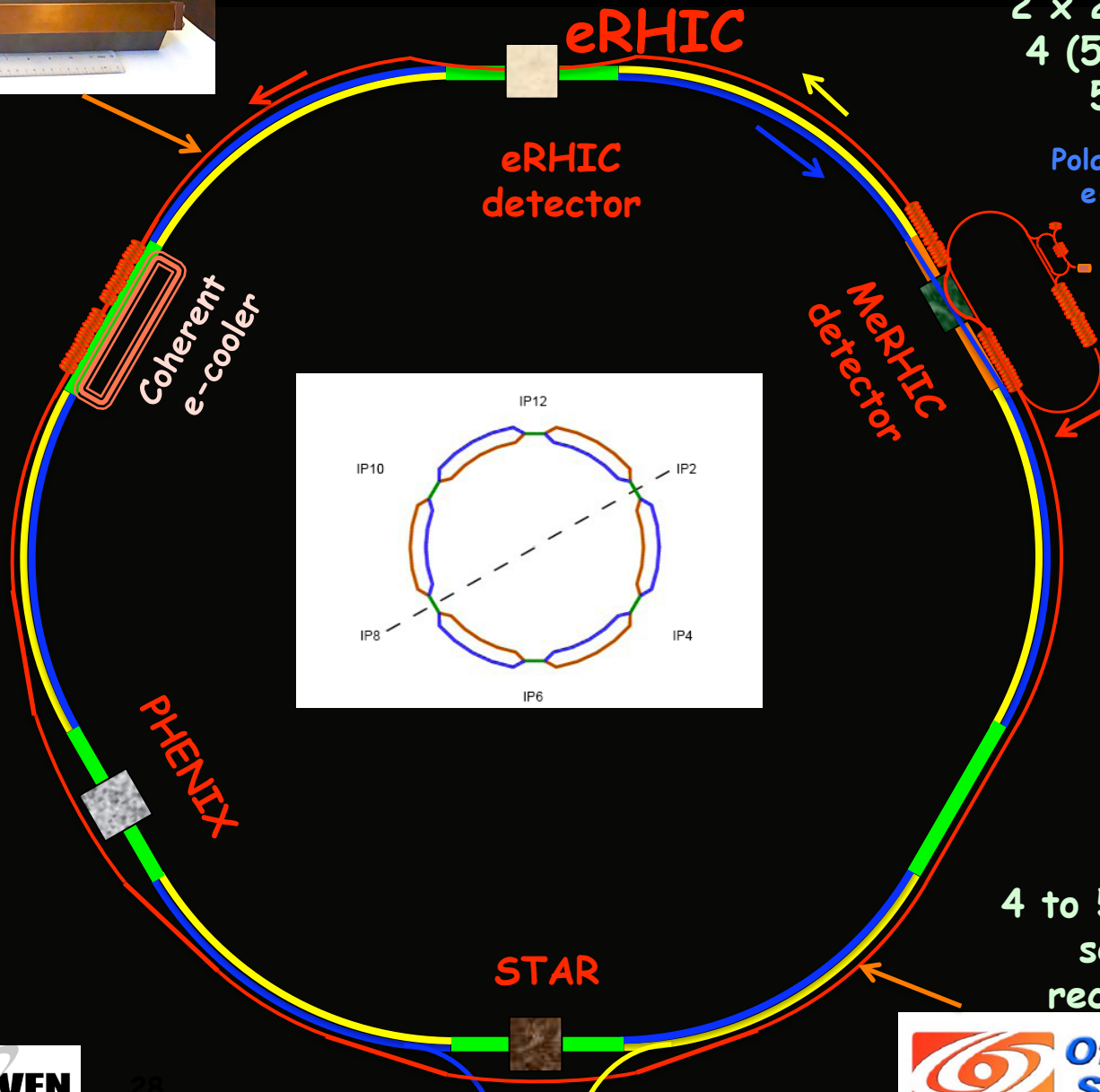
See Litvinenko presentation



10 (20) GeV e x 200 (325) GeV p -
100 (130) GeV/u Au



Possibility
of 30 GeV
low current
operation

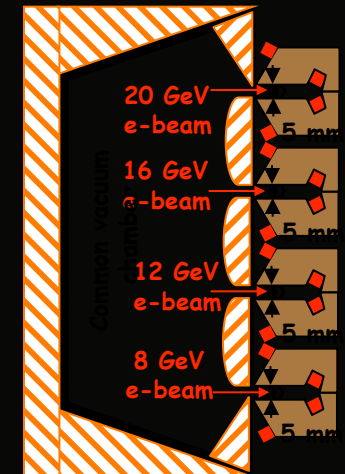


2 x 200 m SRF linac
4 (5) GeV per pass
5 (4) passes

Polarized
e-gun

Beam
dump

MeRHIC
detector



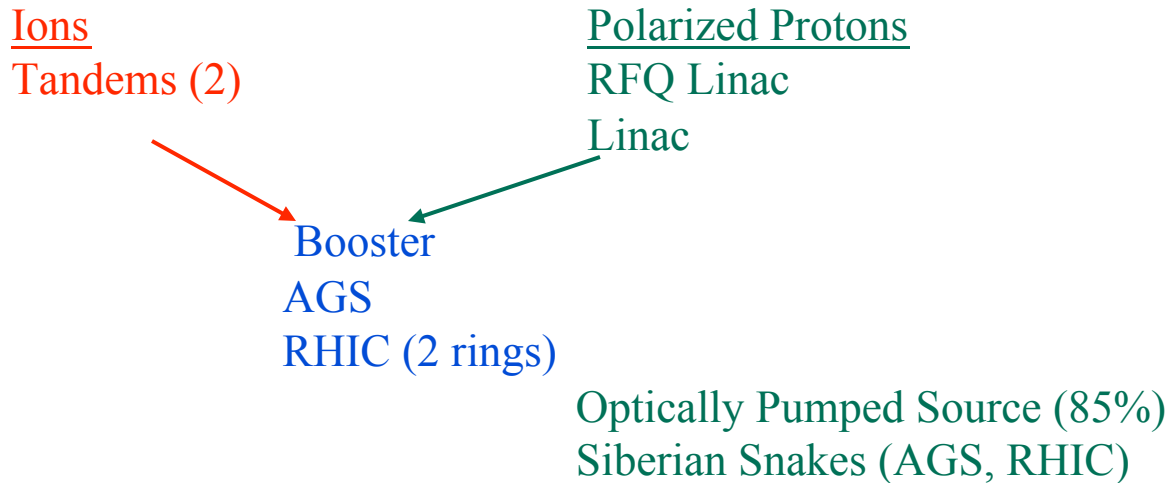
4 to 5 vertically
separated
recirculating

COSTS

What are the Cost Drivers?

- Labor costs to run and maintain accelerators and experiments
 - 24 x 7 RHIC operations
 - Complex facility needing substantial maintenance
- Power
 - Determines the number of running weeks
 - NYPA contract extended for 18 months
 - 15 year contract under discussion
- Materials purchases, consumables to maintain accelerators
 - Incremental M&S costs (beyond 20 week level) \$138K (FY09\$) / week
- Allocated charges such as space charge and cyber security continue to grow and are substantial

Size and Complexity: 8 Accelerators

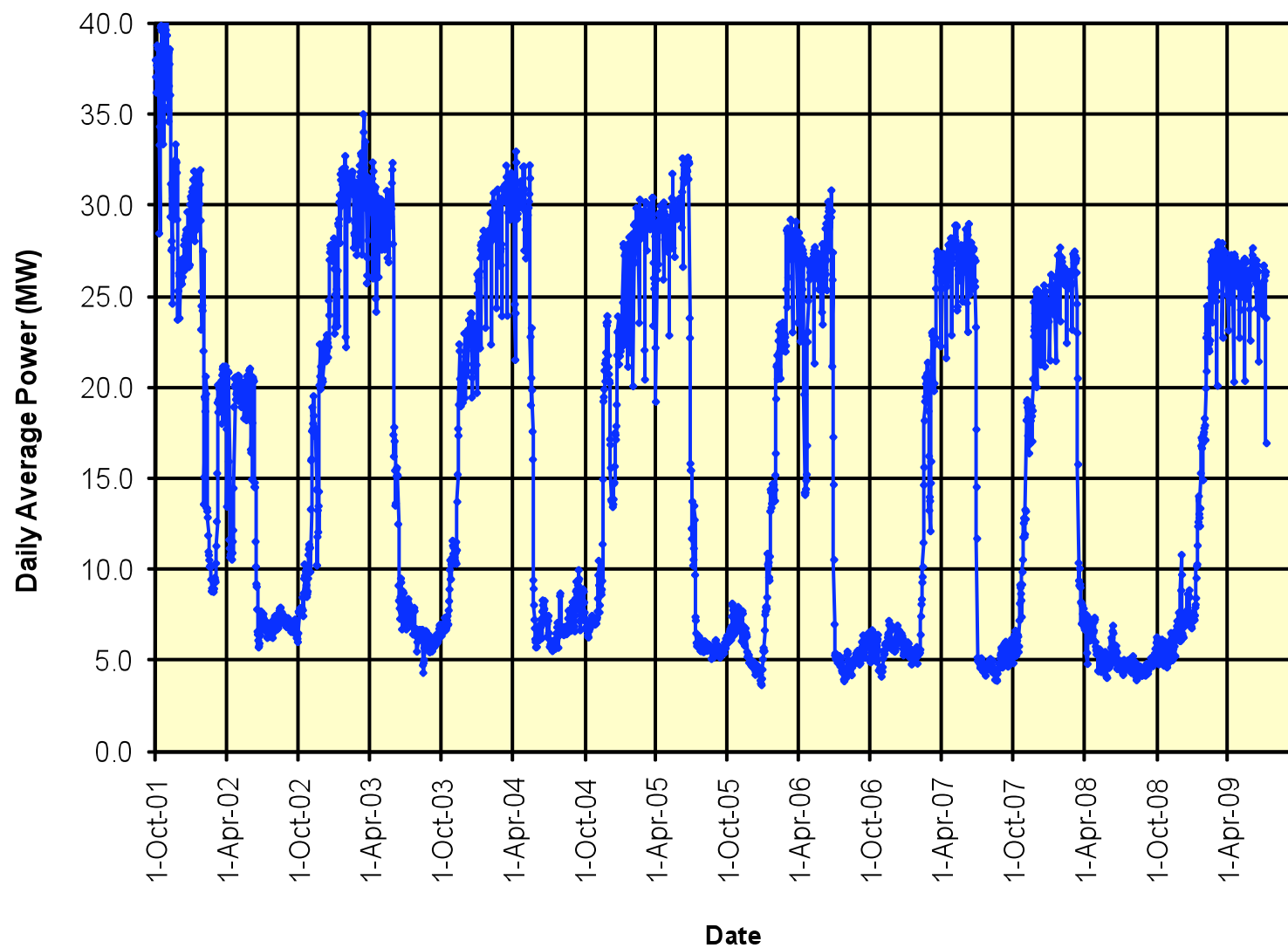


- ~500,000 control points and ~16,000 imbedded processors
- 10 km vacuum ($<10^{-10}$ Torr)
- 7.3 km superconducting magnets and cryostats (~1800 supercon. magnets)
- 25 kW refrigerator (4.5⁰K)
- 90 MVA generator
- 42 high power RF (0.1-200 Mhz)
- 1300 programmable power supplies
- 54 pulsed power systems
- 30 MW electrical power usage

Flexibility

- Variation in particle **species**, also asymmetric
 - So far Au+Au, Cu+Cu, d+Au, p↑ +p↑
- Variation in beam **energy**
 - Au+Au at 4.6, 10, 28, 31, 66, 100 GeV/u
 - Cu+Cu 11, 31, 100 GeV/u
 - p↑+p↑ at 31, 100, 250 GeV
 - Low energy p↑ 22.5 GeV commissioning, equiv. 9.2 GeV Au x Au
- Variation in **lattice configuration**
 - Low b^* in most cases (.7-3 m)
 - Large b^* for small angle scattering experiments (>10 m)
 - Polarity change in some experimental magnets
- **Polarization**, variable orientations and polarization patterns

C-AD Energy Use FY 2002-9



C-AD RHIC Operations

(\$ in Millions)

	FY 04	FY 05	FY 06	FY 07	FY 08	FY 09 Allocated	FY 10 Presidential
Labor	37.8	40.1	39.4	41.8	42.5	44.5	46.9
Distributed Technical Services	3.6	3.4	3.7	4.5	4.2	5.0	5.2
M&S	8.3	8.2	11.6	10.8	9.6	8.9	9.5
Power	8.4	9.5	8.6	6.5	8.4	8.1	13.3
Allocated Costs	4.1	4.8	4.8	5.2	5.2	5.7	5.8
Space	6.4	7.1	8.1	8.9	9.6	9.8	10.5
Organizational Burden	2.9	3.0	2.9	3.7	3.6	4.0	4.2
Material Handling Burden	0.6	0.6	0.7	0.8	0.7	0.7	0.7
Overhead	22.4	23.9	24.3	26.5	26.3	28.7	30.2
Total Operating Cost	\$94.5	\$100.6	\$104.1	\$108.7	\$110.1	\$115.4	\$126.3
Stony Brook Foundation			-\$11.2				
Power Rebate	-\$1.0		-\$0.6		-\$1.5		
Prior Year Carry Forward						-\$1.5	-\$3.0
Carry Forward					\$1.5	\$3.0	\$3.0
Total NP Budget Authority	\$93.5	\$100.6	\$92.3	\$108.7	\$110.1	\$116.9	\$126.3
Manpower in FTE's	349.5	350.5	336.5	341.6	337.8	340.0	350.0
Cryo Weeks of Operations	26.7	31.4	21.2	18.4	19.2	22.0	30.0

AIP

(\$000)	FY2007	FY2008	FY2009	FY2010E	FY2011E	FY2012E	FY2013E	FY2014E
RHIC cryo control system upgrade	200	150	100	450				
Main Control Room consolidation and upgrade	500	450	175	1,375				
RHIC SRF (56 MHz)	-	1,300	1,225	1,475				
RHIC Blue vertical stochastic cooling	-	-	1,500					
RHIC Blue and Yellow horizontal stochastic cooling	-	-	4,000					
RHIC electron lenses	-	-	4,000					
RHIC collimation upgrade	-	-	-	500	500			
RHIC low energy electron cooling	-	-	-	-	1,600	2,300	900	
Motor control center upgrade	-	-	-	-	1,000			
Westinghouse stator insulation	-	-	-	-	800			
RHIC abort kicker upgrade	-	-	-	-	-	1,800	1,200	
RHIC cold beam pipe in-situ coating	-	-	-	-	-	-	2,100	1,900
RHIC stochastic cooling upgrade to 12 GHz	-	-	-	-	-	-	-	1,250
RHIC SRF (56 MHz) 2nd cavity	-	-	-	-	-	-	-	1,250
Total AIP	2,100	1,900	11,000	3,800	3,900	4,100	4,200	4,400

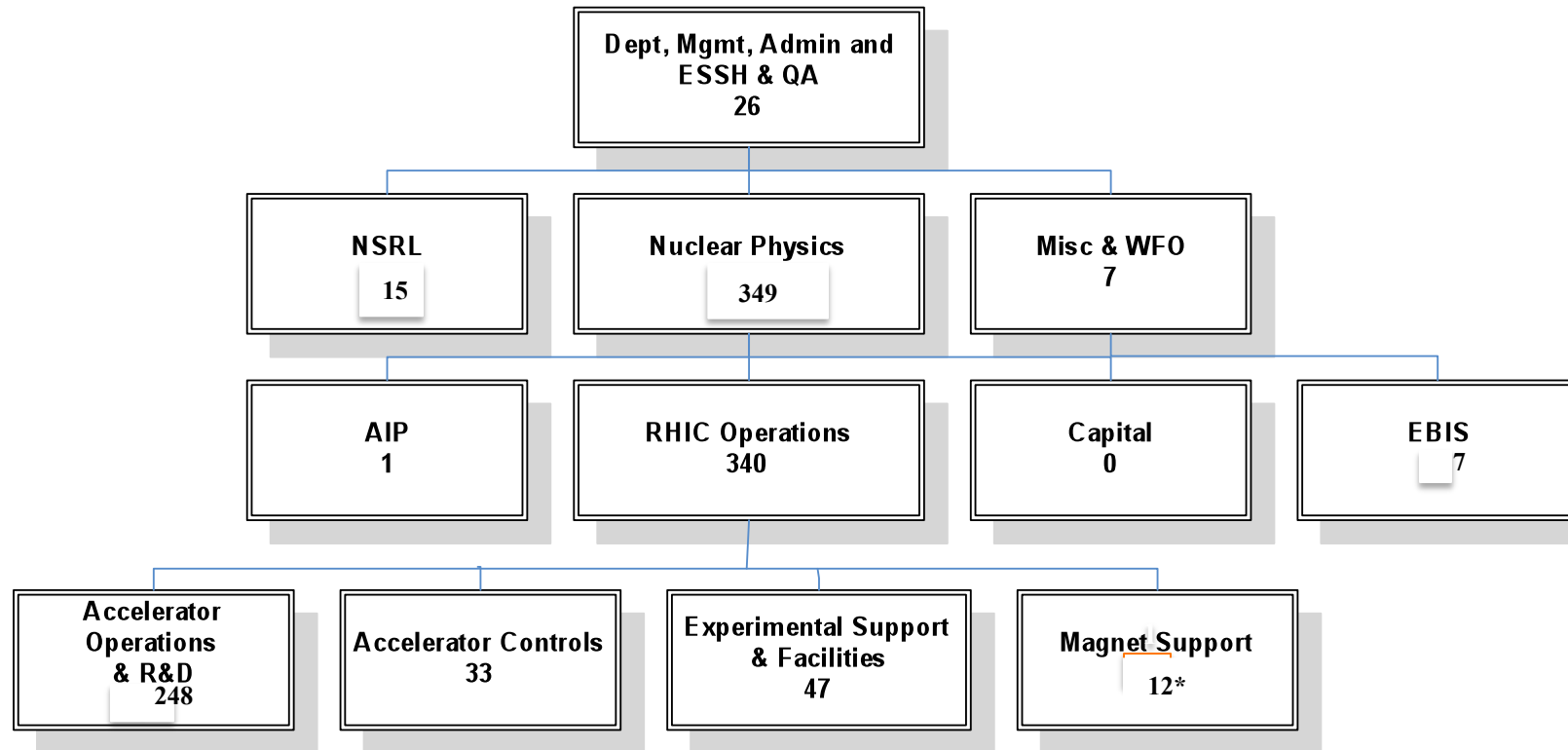
SUMMARY

- **RHIC unlike other high energy accelerators RHIC provides the physics community with a wide variety of ion species and a unique polarized proton program.**
- **With the completion of the EBIS Project in FY2010, RHIC will cover the full range of species from hydrogen to uranium.**
- **Upgrades are underway to provide a significant increase in delivered luminosity (“RHIC II”)**
- **The design and r&d for a future electron-ion and polarized electron-polarized proton is actively being pursued. A stepwise approach, MeRHIC, to the ultimate facility, eRHIC, is likely to be the best and most cost effective approach to enter into the new physics regime.**

ADDITIONAL MATERIAL

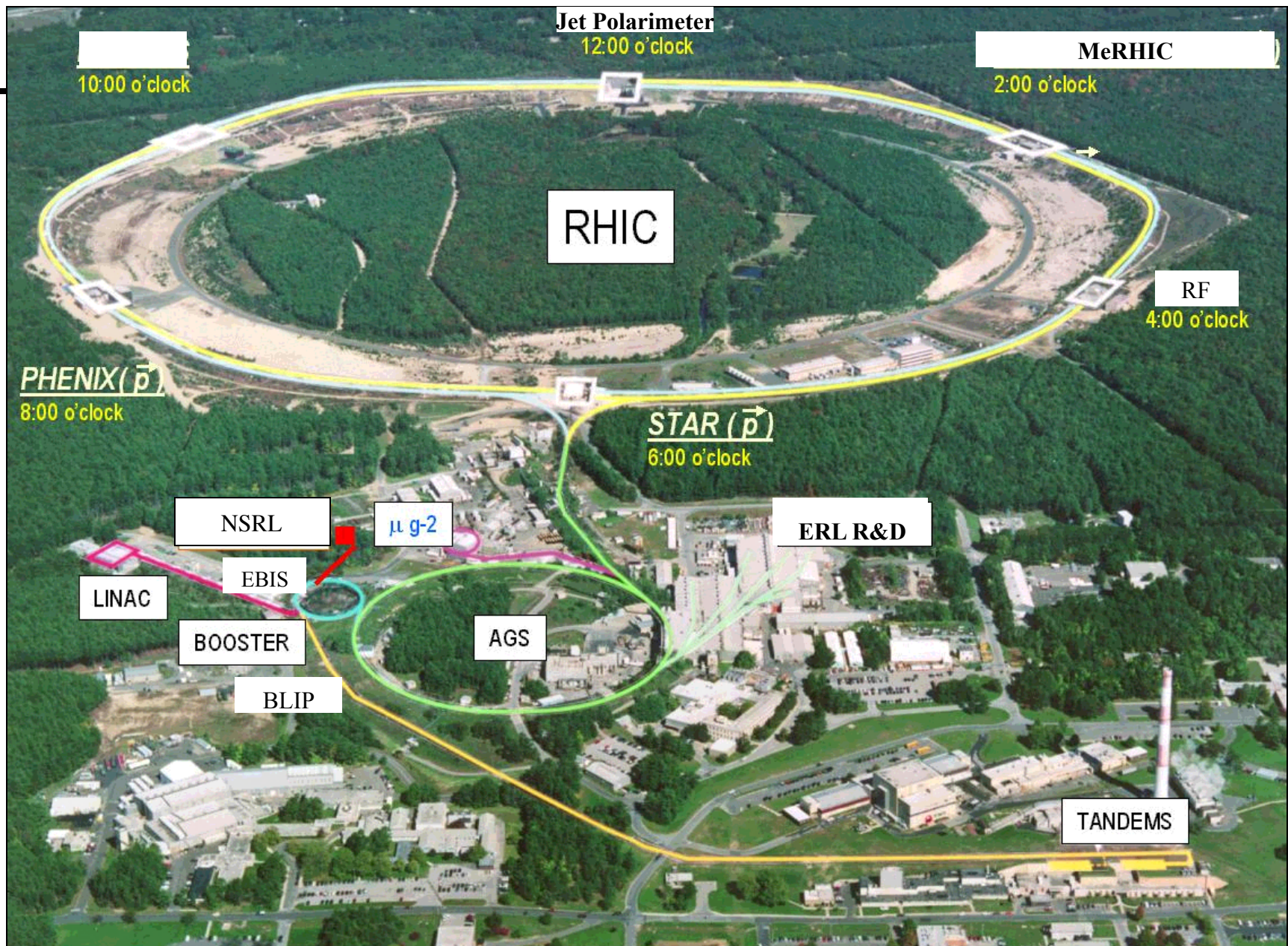
Collider-Accelerator Department**

(Programmatic Heads 371)

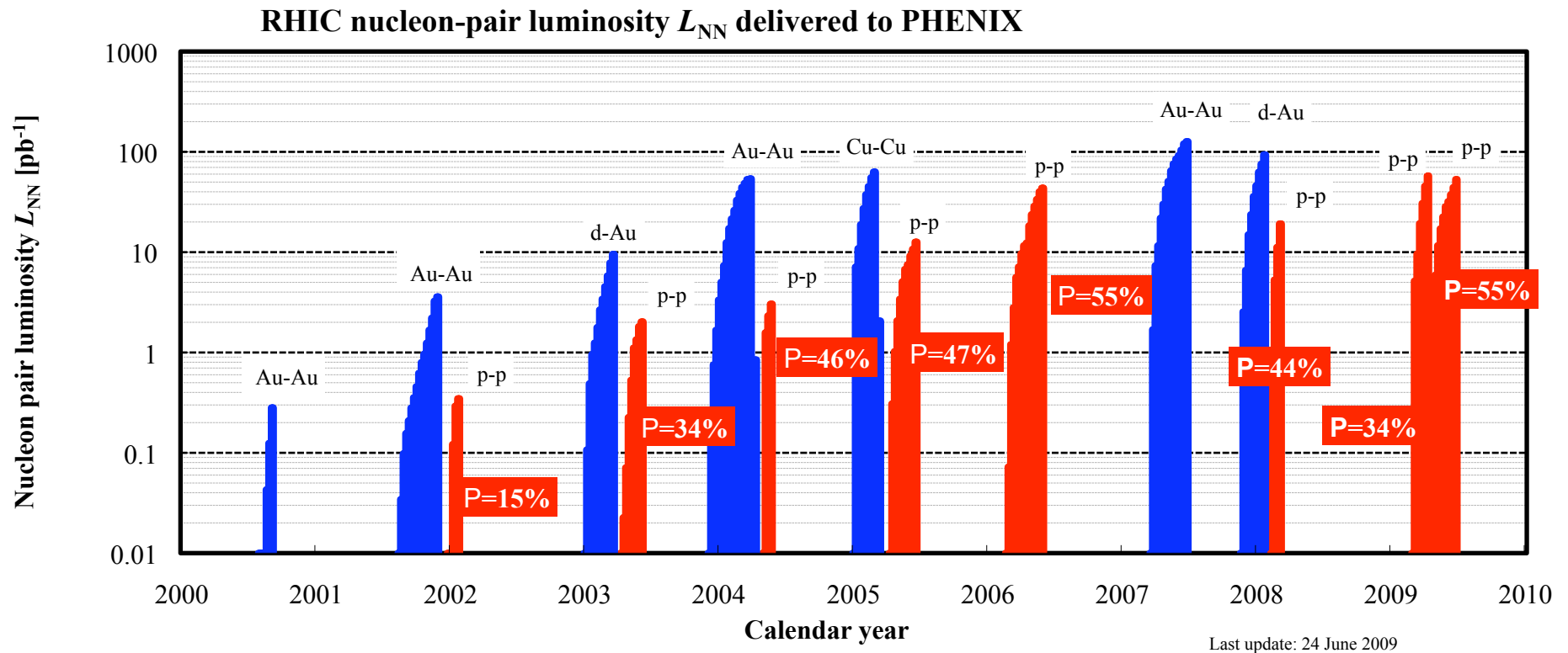


**Reflects Head data circa May 2009

*Superconducting Magnet Division
Personnel



RHIC Delivered Integrated Luminosity History



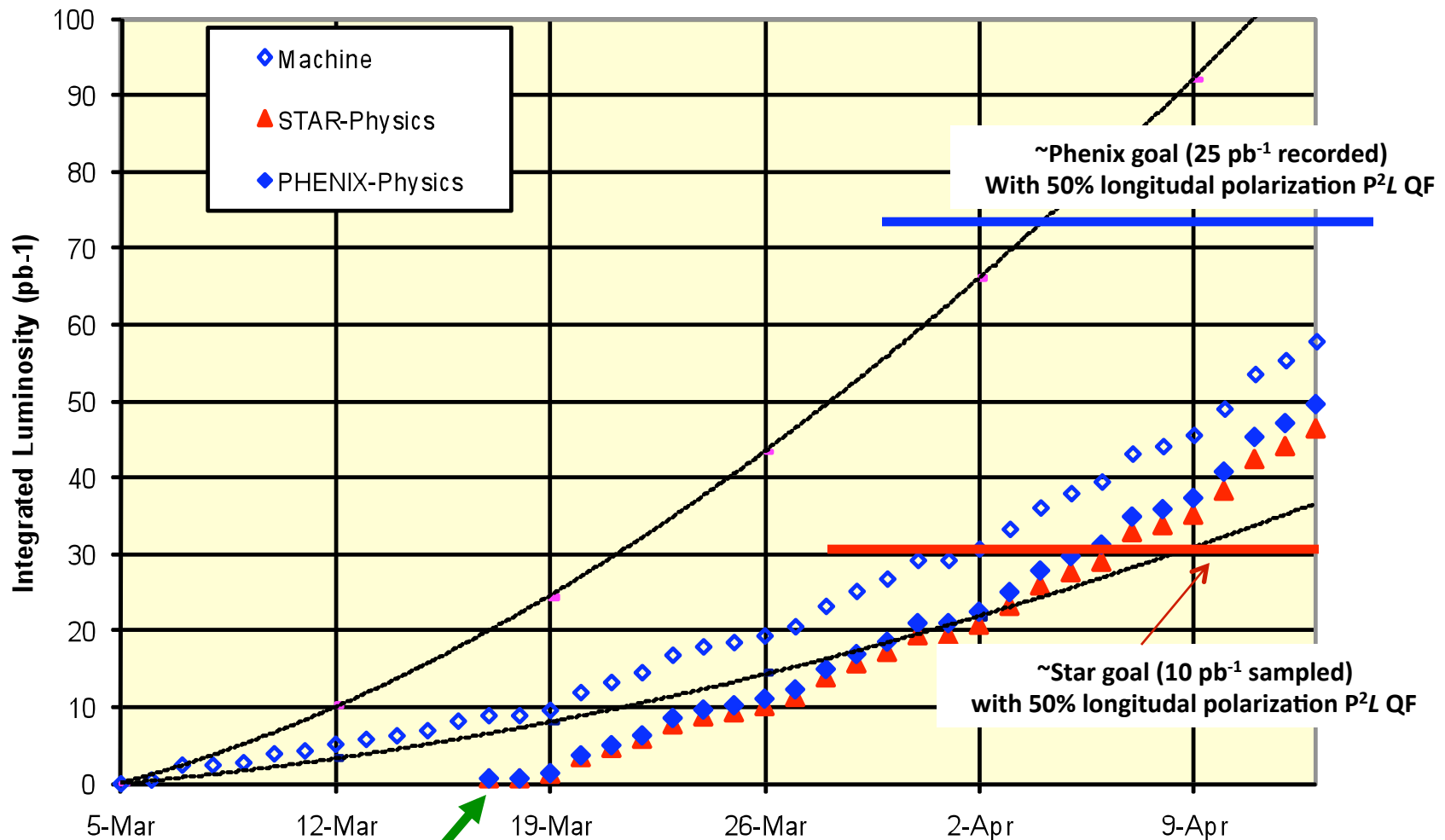
C-AD Accelerator Community Leadership Positions

- **Member, APS-DPB Executive Committee – M. Minty**
- **Member, ICFA Beam Dynamics Panel – W. Fischer**
- **Chair, PAC Organizing Committee; Chair 2011 PAC – T. Roser**
- **Member, Board of Directors International Nuclear Target Development Society; Member Scientific Advisory Committee for the Heavy ion Ion Accelerator Technology Conferences – D. Steski**
- **Chair, FEL Prize Committee; Member, International FEL Executive Committee; Member, USPAS Curriculum Committee; Member, APS Fellowship Committee; Chair, PAC 2011 Scientific Program Committee; Member, IPAC 2010 Scientific Program Committee; Member, IPAC 2010 International Organizing Committee; Member, IPAC 2011 Scientific Program Committee; Member, PAC 2009 Scientific Program Committee; Member, PAC 2009 International Organizing Committee; Member, PAC University Professors Subcommittee – V. Litvinenko**
- **Chair, US Particle Accelerator School Board of Governors; Member, UK MICE Oversight Committee; Member, UK Accelerator R&D Centres Review Panel – D. Lowenstein**
- **Deputy Director, Center for Accelerator Science and Education, Stony Brook University and BNL; Chair, Particle Accelerator Science and Technology Technical Committee, IEEE/NPSS (until January 2009); Member, ICFA Panel of Novel and Advanced Accelerators; Member, FNAL Accelerator Advisory Committee; Member, Navy High Energy Laser TAWG (Technical Advisory Working Group); Member, PAC and IPAC Organizing Committees – I. Ben-Zvi**
- **+ others serving on DOE, NNSA, NSF, CERN, RAL, GSI, J-PARC committees and reviews**

Injuries in FY09

Date	Description	Injury Type
5/19/2009	An employee was discarding a wooden drawer and received small splinters in the hand. At the clinic, he received first aid and returned to normal duties.	First Aid
4/28/2009	An employee slipped and injured his thigh. He was treated and sent home to rest.	Recordable - DART
3/30/2009	An employee was walking outdoors on a windy day and was struck in the eye by wind, dust or dirt. At the OMC he was examined, received first aid treatment and returned to work.	First Aid
12/19/2008	Employee slipped on icy grass coming down the hill. Employee injured right ankle and was transported to ER, examined and returned to work. Although not used, medication for pain was prescribed making this recordable.	Recordable
11/4/2008	An employee backed into a hot pipe and received a small first degree burn on the back of his neck. At the OMC, he received first aid treatment.	First Aid
10/21/2008	An employee bent over to pick up tool and struck head while straightening up. At the OMC, he received first aid treatment.	First Aid
10/16/2008	An employee twisted his knee while walking down steps, significantly exacerbating an old injury. This a recordable case due to prescription medication administered by his doctor.	Recordable - DART

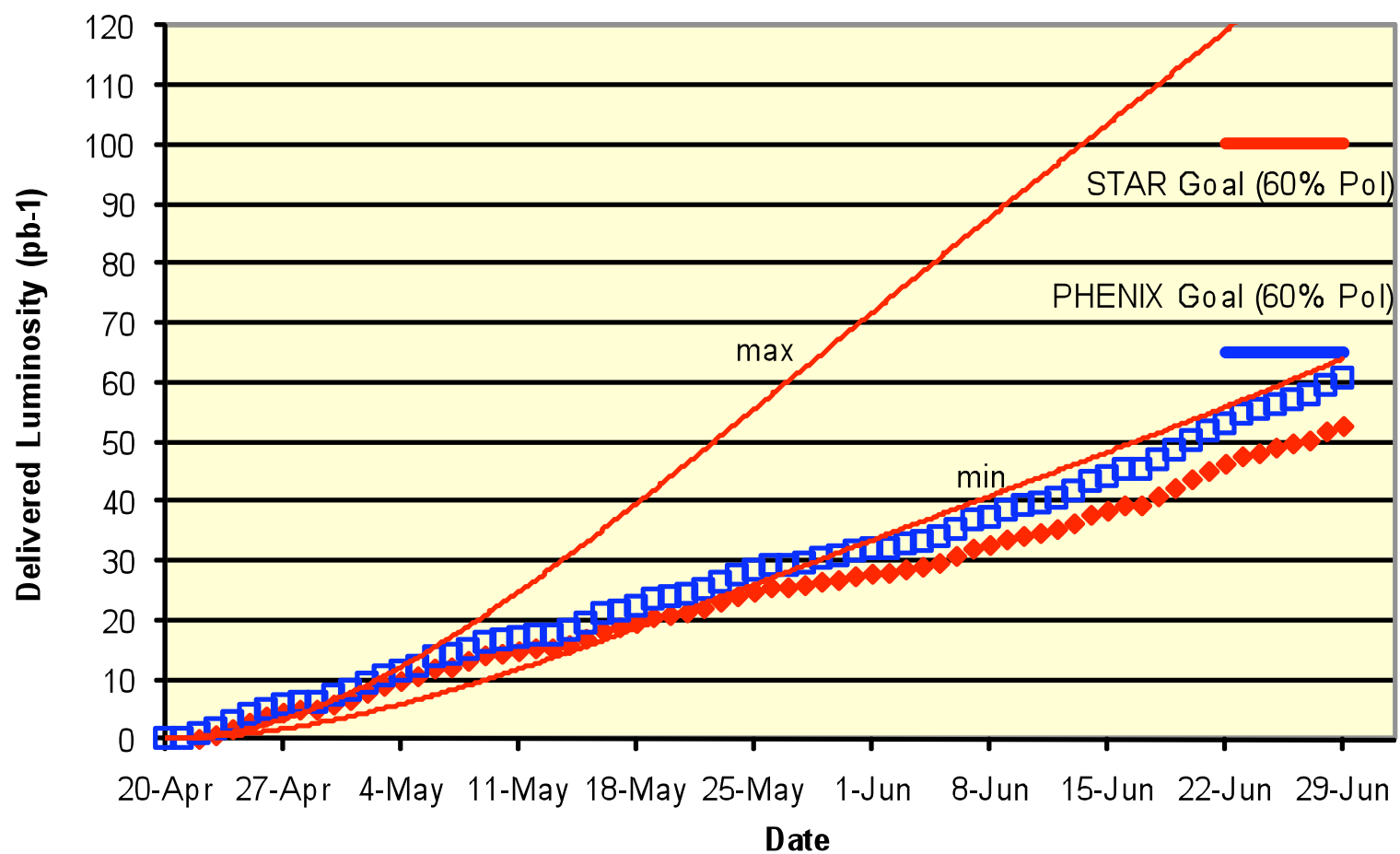
Run 9 250 x 250 GeV polarized protons Integrated Luminosity - Final



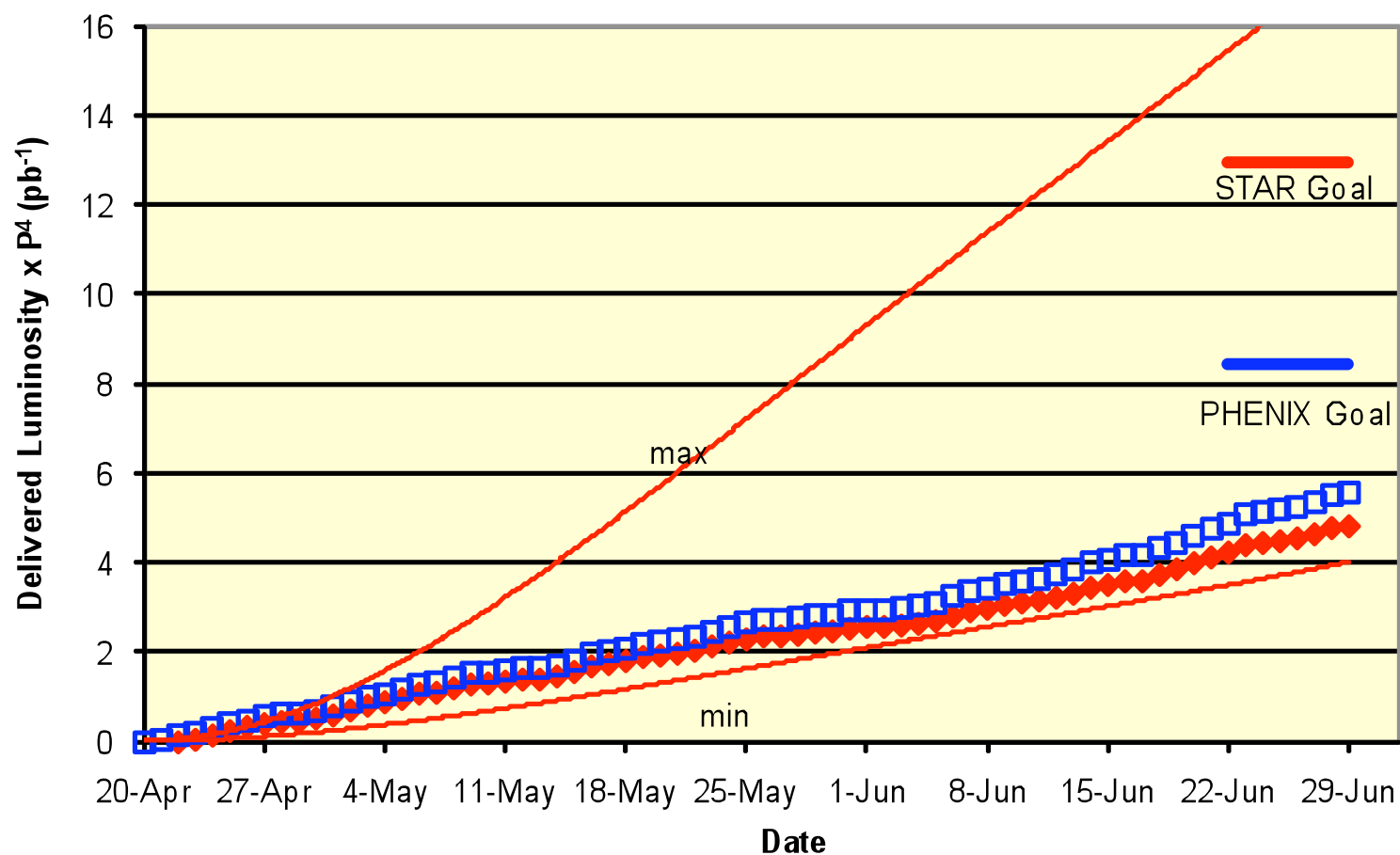
Experiments start physics with longitudinal polarization

Blue average polarization (preliminary Jet target) = $33.1 \pm 0.8 \%$
 Yellow average polarization (preliminary Jet target) = $35.1 \pm 0.9 \%$

Run 9 100 x 100 GeV pp, Luminosity - Final



Run 9 100 x 100 GeV pp, P⁴ x Luminosity - Final, Jet Target
 preliminary polarization averages for run, B=55.4%, Y=54.8%

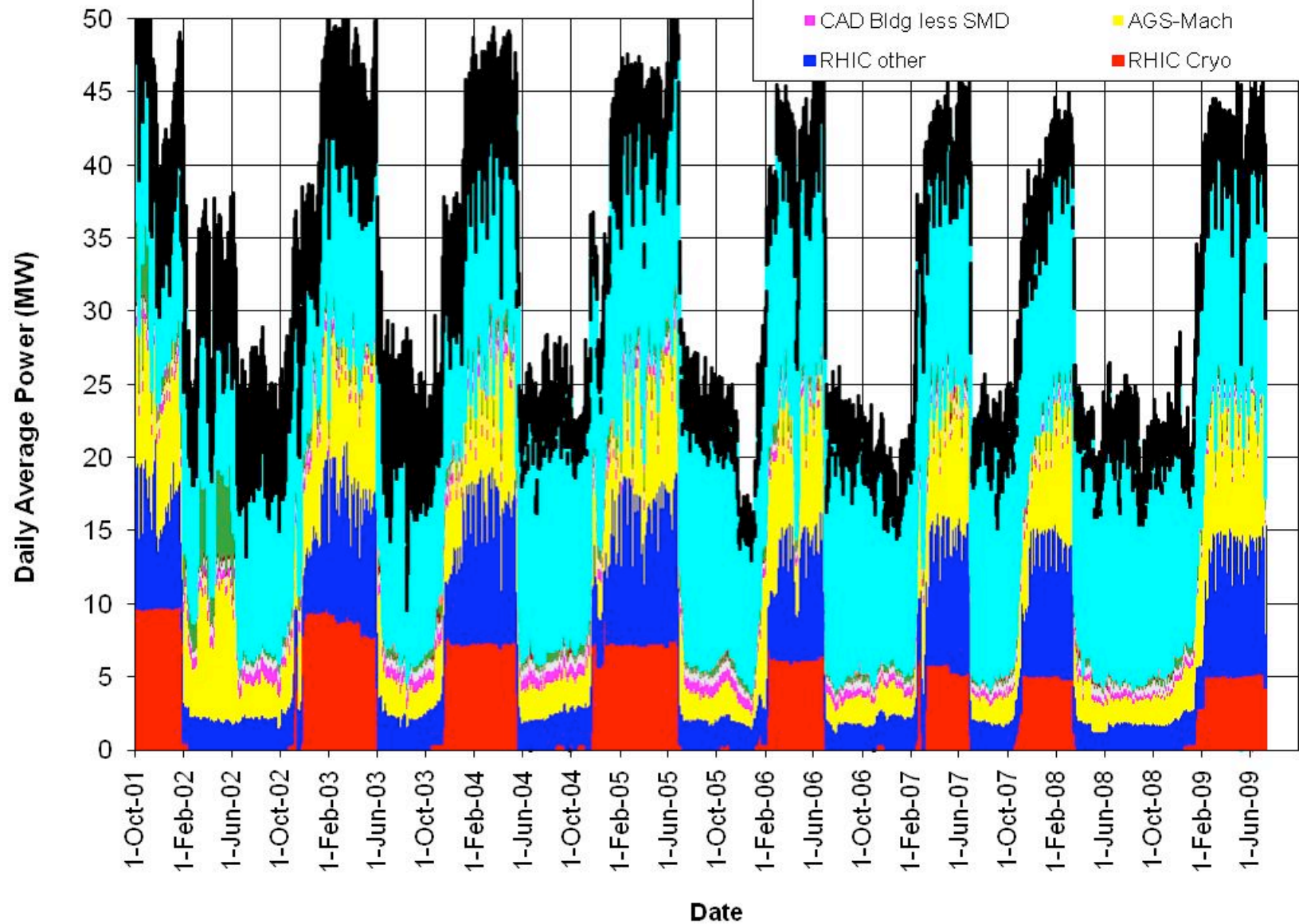


Energy Recovery Linac (ERL) Milestones

ERL Project Start	02/03/03
50 kW Transmitter Installed & Running (5-cell)	07/15/04
5-cell Cavity Fabrication Complete	01/31/06
ERL Facilities in place (Blockhouse, Control Room, Utilities, etc.)	05/23/07
5-cell Cavity Processing/String Assembly Complete	03/31/08
5-cell Cryomodule Installation Complete	10/06/08
Klystron System Reaches 1 MW	12/16/08
5-cell Cryomodule Cold Emission Start	03/12/09
=====	
Gun Cavity Fabrication Complete	07/30/09
ERL Loop Magnet Installation Complete	01/25/10
Gun Cavity Processing/String Assembly Complete	05/23/10
Gun Cryomodule Installation Complete	07/01/10
Gun to 5-cell Test Beamline Installation Complete	07/22/10
Gun to 5-cell (G5) Testing Start	08/13/10
G5 Testing Complete G5 Test Beamline Removed	10/26/10
ERL Loop Systems Installed & Tested	12/04/10
ERL Injection Line Installation Complete	12/21/10
Full ERL Testing Start	12/21/10

BNL Energy Use FY 2002-9

(C-AD Bldg 911 power is in AGS-Exp/Mach)

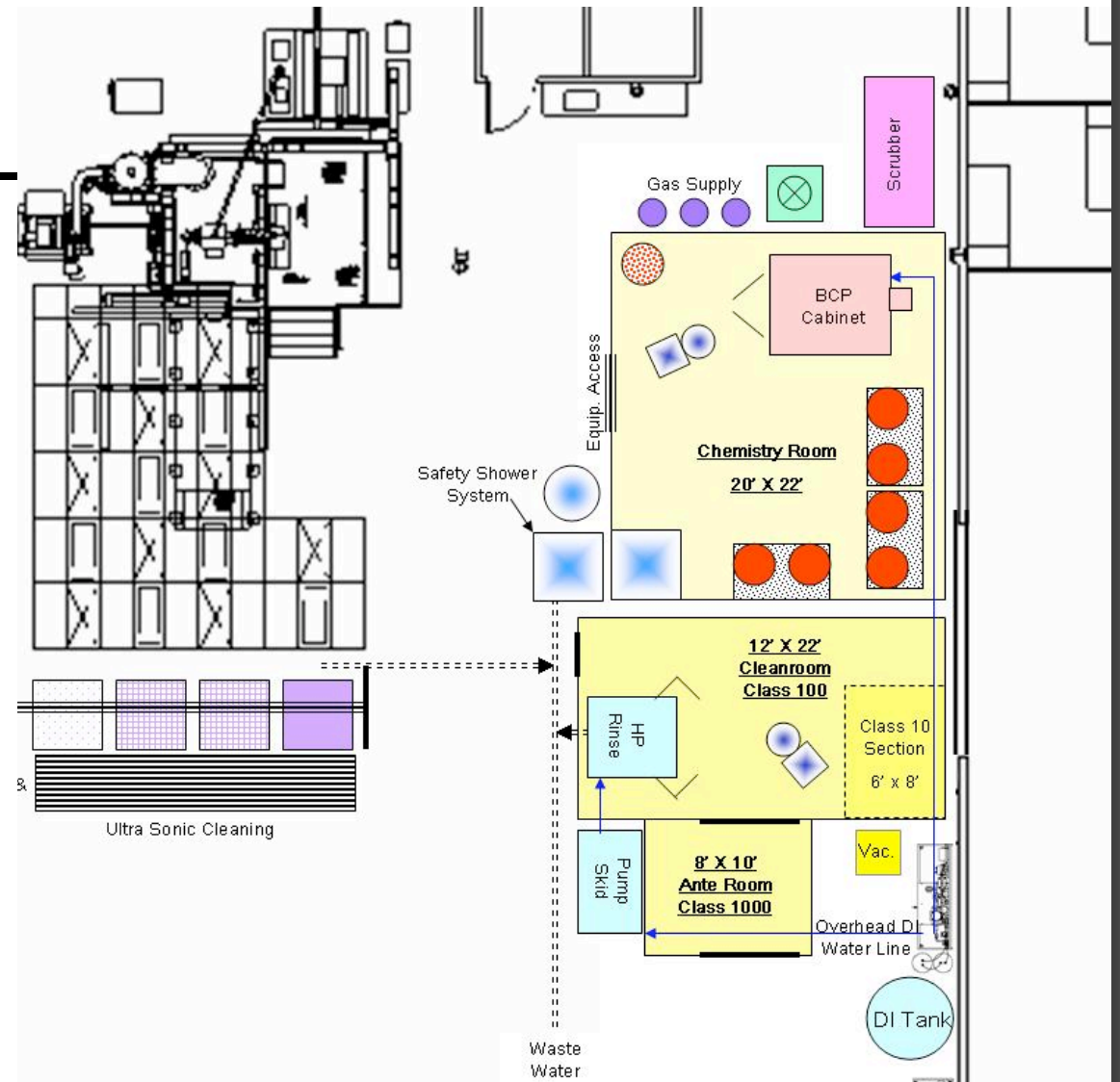


Specifications

- DI water system and ultrasonic cleaning tanks in place.
- Chemistry Cabinet
 - Designed for cavity 72" long, 48" diameter 800 lb empty cavity weight
- High Pressure Rinse Cabinet
 - Designed for cavity 72" long, 48" diameter, unique ability to offset the wand head to clean "off axis", necessary for the 56 MHz coax cavity. This option does not exist elsewhere.
- The overall length and width of cavities that can be accommodated in these cabinets far exceeds that presently available at any other national lab.
- These systems were designed to accommodate the 56 MHz RHIC cavity

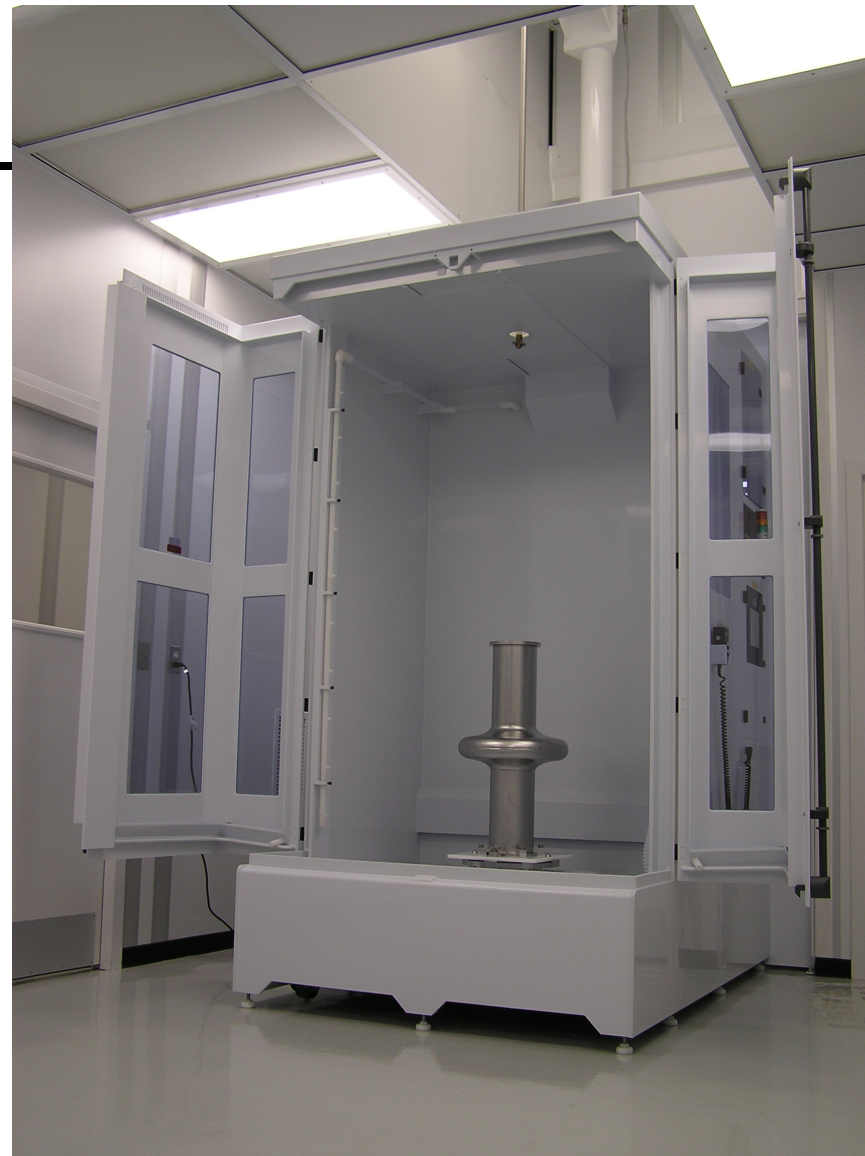
Overall Layout of the facility

- Cavity Processing Facility
 - ultrasonic cleaning tanks
 - chemistry facility for cavity etching
 - High Pressure Rinse for cavity
- Cleaning
 - Class 100 and Class 10 cleanroom for cavity assembly



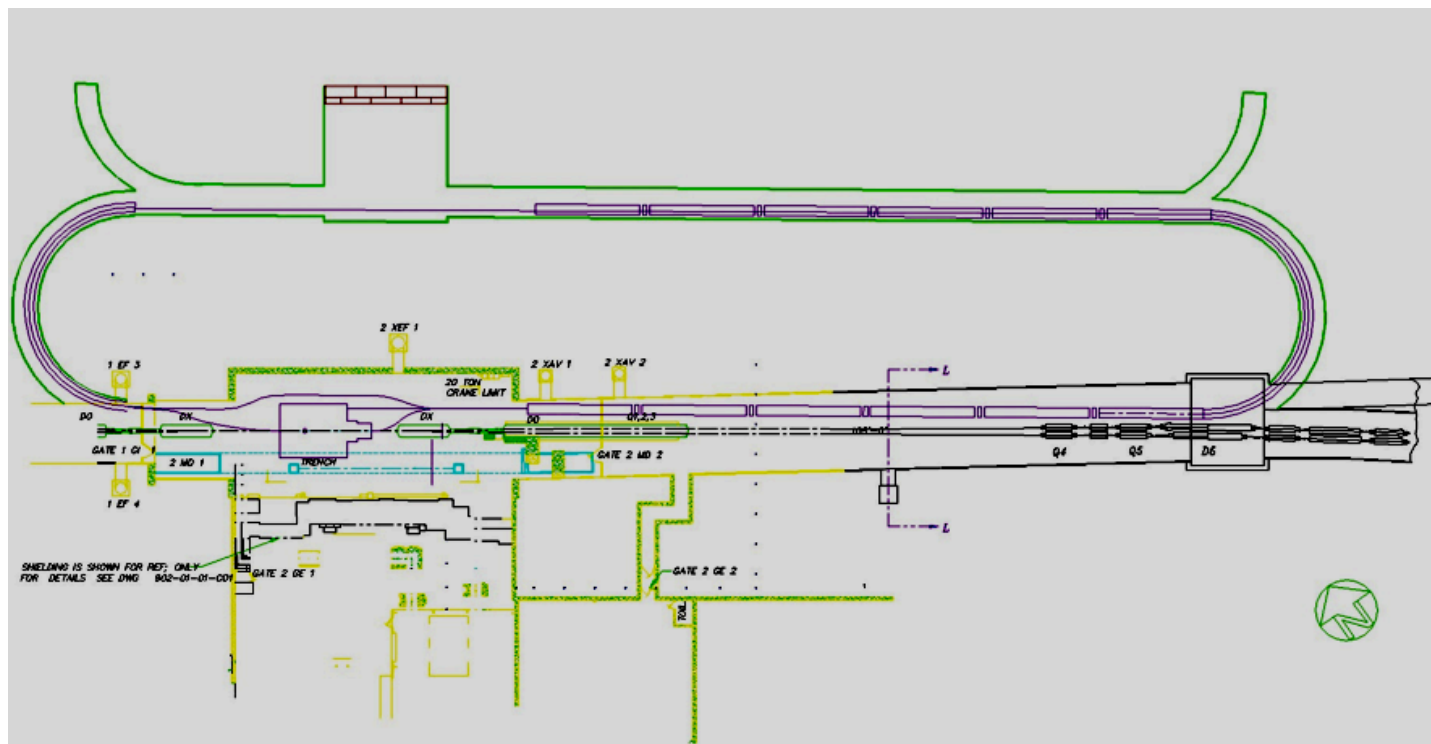


Buffer Chemical Polishing (BCP) cabinet
in final fabrication



High Pressure Rinse Cabinet with
Single cell 750 MHz cavity shown

MeRHIC



C-AD Budget History

		FY 04	FY 05	FY 06	FY 07	FY 08	FY 09	FY 10
								Guidance
Funding	Accel Ops	84,335	91,306	83,621	99,694	99,600	107,770	117,130
	Supplemental Funding					1,458		
	Accel R&D	2,000	1,970	1,850	2,045	2,500	2,250	2,000
	Exp Support	<u>7,158</u>	<u>7,300</u>	<u>6,791</u>	<u>6,958</u>	<u>6,493</u>	<u>6,832</u>	<u>7,158</u>
	RHIC Operations	93,493	100,576	92,262	108,697	110,051	116,852	126,288
	AIP	2,900	3,100	1,500	2,100	1,900	3,000	3,800
	AIP (ARRA)						8,000	
	Accel CE	1,200	1,200	622	1,000	700	2,140	1,500
	Exp Support CE	625	260	100	0	75	200	200
	CDR, R&D, Preops	0	700	0		0	300	0
	PED/Construction	<u>0</u>	<u>0</u>	<u>2,080</u>	<u>5,120</u>	<u>4,162</u>	<u>2,438</u>	<u>0</u>
	EBIS	0	700	2,080	5,120	4,162	2,738	0
	CIRC	0	0	0	0	0	0	0
	eRHIC	0	0	0	0	0	0	0
Total DOE Funding		98,218	105,836	96,564	116,917	116,888	132,930	131,788
# Budgeted Run Weeks		26.7	31.4	21.2	18.4	19.2	22.0	30.0
User Support Funding		FY04	FY05	FY06	FY07	FY 08	FY 09	FY 10
	Accelerator Ops (-1)	313	660	565	664	50	0	0
	Experimental Support (-2)	<u>356</u>	<u>22</u>	<u>69</u>	<u>0</u>	<u>383</u>	<u>470</u>	<u>480</u>
	Total C-AD Provided User Support	669	682	634	664	433	470	480
	Total PO Provided User Support (-2)	339	343	317	332	192	260	240
Total Nuclear Physics User Support		1,008	1,025	951	996	625	730	720

NSRL Summary for 2009*

	Run 08C	Run 09A	Run 09B
Weeks of Running	8	10	6
Experiments Run	41	44	25
Users Participating	136	151	150 [†]
Institutions Participating	35	33	50 [†]
Hours of Operation	474	487	258

*NSRL program receives Booster beam when RHIC is not being filled.

[†] NASA Summer School participants included.

Numbers for Run 09B are still preliminary.